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MTSE 655-101: Diffusion and Solid State Kinetics

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New Jersey Institute of Technology

Department of Physics

MTSE 655-101

(CRN: 94782)

Fall 2021

DIFFUSION AND SOLID STATE KINETICS – Course Outline

Instructor: Dr. Andres Jerez, Tiernan Hall 455, **Email:** jerez@njit.edu

Tuesday 6:00 pm – 8:50 pm, FMH 106

Textbook: R. W. Balluffi, S. M. Allen, W. C. Carter, **KINETICS OF MATERIALS**, Wiley, 2005, ISBN-13: 978-0471246893

Course Website: <http://canvas.njit.edu/>

Course Description:

This course presents a unified treatment of phenomenological and atomistic kinetic processes in materials. It provides the foundation for the advanced understanding of processing, microstructural evolution, and behavior for a broad spectrum of materials. The course emphasizes analysis and development of rigorous comprehension of fundamentals. Topics include: irreversible thermodynamics; diffusion; nucleation; phase transformations; fluid and heat transport; morphological instabilities; gas-solid, liquid-solid, and solid-solid reactions.

Learning Outcomes:

As diffusion is one of the fundamental mechanisms in the processing of materials, from steel to semiconductor devices, students taking this course will become familiar with both the macroscopic and the atomic description of diffusion. They will learn how to characterize diffusion phenomena in dilute alloys as well as in ionic and covalent solids. High atom mobility effects at defect sites and surfaces are examined. Chemical kinetics and kinetics of phase transformations including nucleation, growth, and spinodal decomposition are discussed.

| Date: | Subject (book chapter): |
|--------------|--|
| 09/07 | Introduction (Ch. 1), Irreversible Thermodynamics (Ch. 2) |
| 09/14 | Driving Forces and Fluxes for Diffusion (Ch. 3) |
| 09/21 | The Diffusion Equation (Ch. 4) |
| 09/28 | Solving the Diffusion Equation (Ch. 5-6) |
| 10/05 | Atomic Models for Diffusion (Ch. 7) |
| 10/12 | Diffusion in Crystals (Ch. 8) |
| 10/19 | <i>Midterm Exam (Ch. 1-8)</i> |
| 10/26 | Diffusion along Crystal Imperfections (Ch. 9) |
| 11/02 | Diffusion in Non-crystalline Materials (Ch. 10) |
| 11/09 | Particle Coarsening, Grain Growth, Diffusional Creep and Sintering (Ch. 14-16) |
| 11/16 | Phase Transitions, Spinodal and Order-Disorder Transitions (Ch. 17-18) |
| 11/23 | Nucleation (Ch. 19) |
| 11/30 | Diffusional Growth, (Ch. 20-21) |
| 12/07 | Presentations |
| (Dec 14) | <i>Final Exam (Comprehensive)</i> |

Final Grade:

Midterm Exam: 30%

Final Exam: 30%

Homework: 20%

Presentation: 20% (Presentation and report-details will be discussed in the class)